Forest Research Information Paper No. 104

Thinning Clumps of Northern Hardwood Stump Sprouts to Produce High Quality Timber

Ontario Ministry of Natural Resources

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Timber cutting in hardwoods often results in stump sprouting, sometimes the only means of regeneration. The species, age of the trees cut, diameter and height of the stump and the location of sprouts on the stump are the major factors influencing development of high quality sprouts. This information paper summarizes types of sprout development and recommends how to thin clumps of sprouts. Photographs of white ash, basswood, white birch, red maple and red oak illustrate practical examples.

COVER PHOTO: Red oak tree with companion stump -- good or bad?

INTRODUCTION

The reproduction of stands from stump sprouts is perhaps the oldest and historically the most widespread of all methods; it has been used for centuries in many parts of the world (Daniel et al. 1979, Koestler 1956). Stump sprouting often accounts for a great part of the reproduction in many hardwood stands as a result of fire or cutting, and thus is an important factor in forest management. For certain species, the reproduction from stumps is simple, rapid and inexpensive. It provides supplemental stocking to the reproduction from seedlings.

Sprouts are just as capable of producing log quality as regeneration of seed origin and sometimes in shorter rotations. The treatment of stump sprouts to produce high-quality timber through judicious thinning requires a/ understanding of various factors influencing sprout development and b/ application of specific silvicultural measures to sustain optimal growth of sprouts. These aspects are discussed in the following sections:

I. Forms of stump sprouts

II. Factors influencing sprout development
   a/ Species
   b/ Age and diameter of the parent stump
   c/ Location of sprouts on the parent stump as related to decay incidence

III. Theory and methods of thinning clumps of sprouts

IV. Recommendations to encourage sprouting and to thin clumps

The information presented applies to white ash, basswood, white birch, red maple and red oak[1], which are frequently found in association with sugar maple in tolerant northern hardwood forests of Ontario. Although the majority of references originate in the USA, the information has been carefully scrutinized for applicability to conditions in Ontario.

[1] See scientific names in Appendix 1.

I. FORMS OF STUMP SPROUTING

A stump sprout originates from concealed dormant buds (Daniel et al. 1979, Smith 1962). Sprouting results when the factors causing bud suppression are removed, e.g., when a tree is decapitated (Blake 1981).

A "stump sprout" develops from a bud on the stump either a/ high up the stump, or b/ near its base or c/ from below the ground (Fig. 1).

A "seedling sprout" originates from the base of cut or broken advanced reproduction, 5 cm in diameter or less (Fig. 2).

Three types of connections between stump sprouts can be recognized: 1/ one (sapling) sprout assuming very early dominance in a clump (Fig. 3), 2/ the V-type, which, with time, may develop into a direct heartwood union of stems (Fig. 4 top), and 3/ the U-type, where two or more sprouts will usually remain separated by space or sapwood (Fig. 4 bottom).

Several sprouts growing in a clump are called "multiple sprouts". These may be clumped as a dense bouquet around the parent stump resulting in severe competition for growing space (Fig. 5 left), or they may be spaced more or less evenly around the stump (Fig. 5 right).

FIGURE 1. White ash stump 20 cm diameter with sprouts a/ high up on the stump, b/ near its base and c/ from below the ground line.

FIGURE 2. One-year-old white ash seedling-sprout developed as a result of breakage of original stem.

FIGURE 3. Red oak sapling-sprout from a stump 6.3 cm diameter assumed dominance after 2 growing seasons. Ideal regrowth 2.7 m in height after 3 growing seasons.

II. FACTORS INFLUENCING SPROUT DEVELOPMENT

a/ Species

The assessment of the sprouting ability is based on the number of stumps sprouting (sprouting frequency) and number of sprouts per stump (sprouting capacity) over a wide range of ages and diameters. The sprouting ability, particularly capacity, is in part hereditary (Little Jr. 1938, McIntyre 1936, Shipman 1972).

Generally, most northern deciduous hardwood species sprout well from stumps up to pole-size. Basswood is an exceptionally prolific sprouter from small and large stumps (Buttrich 1923, Crombie 1965, Frothingham 1915, Morton 1920, Tillotson 1921, Zon 1929), and continues to sprout at the base even after repeated burnings; sugar maple, and to a lesser extent, red oak are fire-sensitive and less likely to sprout (Braun 1950). Red oak can also produce an abundance of sprouts from stumps of trees larger than pole-size (Wendel 1975). Sprouting varies within genera, e.g., red oak is usually superior to white oak and black oak (Rogers and Rogers 1959, Roth and Sleeth

FIGURE 4. Twin-sprouts of low origin grown over a parent stump without evidence of decay: V-type basswood with a direct heartwood connection (top) and U-type red oak separated by space (bottom).

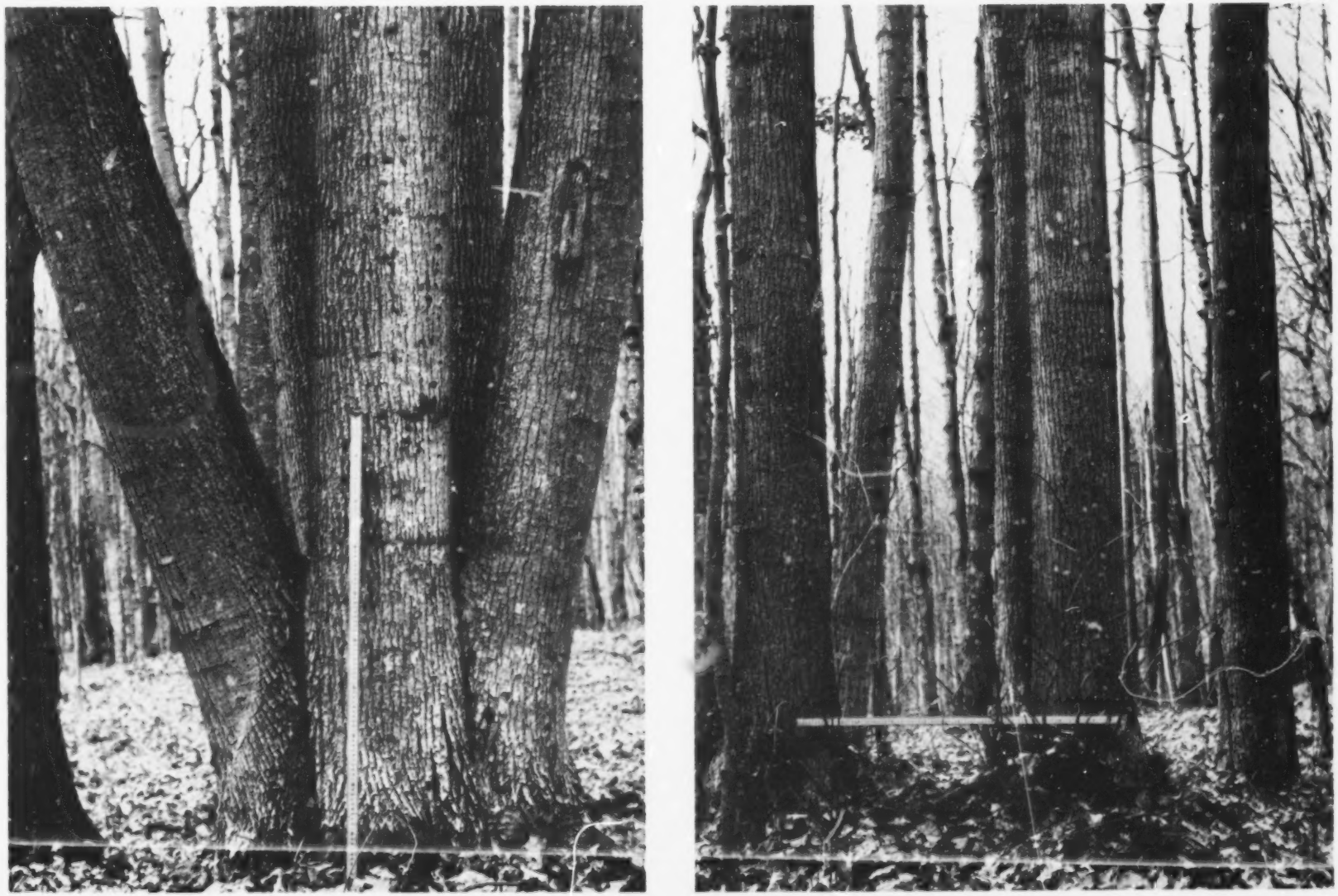

FIGURE 5. Basswood multiple sprouts clumped around the parent stump. When left to grow in a bouquet they create a difficult cutting situation (left). If multiple sprouts are spaced around the parent stump, they offer several safe silvicultural options during the stand rotation (right).

1939, Sander et al. 1976, Spaeth 1928). Table 1 lists the sprouting frequency of some hardwood species.

The sprouting capacity of species may influence the number of sprouts that develop into potential crop trees. For example, basswood had the greatest number followed by black cherry, red maple and red oak, 12 years after cutting (Lamson 1976).

TABLE 1. Sprouting frequency of some deciduous tree species (based on data from Johnson 1975, Leak et al. 1969, Perala 1974, Roth and Hepting 1943b, Spaeth 1928, Tubbs 1977a, Wendel 1975).

Very high	High	Medium	Low
Basswood	White ash	Sugar maple	Yellow birch
Black cherry	Silver maple[1]	White oak	
Ironwood	Red maple	White elm	
	Red oak	Bur oak	
		Black oak	
		White birch	

[1] Personal communication H.C. Larsson.

b/ Age and Diameter of the Parent Stump

Sprouting frequency as well as sprouting capacity of trees often reach an optimum very early in life, but then decline sharply with increasing age and diameter of trees. The thicker bark and reduced vigour of older trees restrict emergence of dormant buds from cut stumps. The growth vigour of the resulting sprouts likewise decreases with increasing age and diameter of trees.

Age

Very little information is available on sprouting frequency in relation to age. In white oak, sprouting frequency was highest at age 40 years (McGee 1978). In white as well as red oak, sprouting capacity was much higher on stumps of cut trees 25-45 years old than on younger or older stumps (McGee 1978, Roth and Sleeth 1939). However, stumps of some fast-growing red oaks produced an increasing number of sprouts per stump even up to age 100 years (Vogenberger 1931, Wendel 1975). In red maple, sprouting capacity was highest on stumps of cut trees 75-85 years old (Prager and Goldsmith 1977). Basswood is the most consistent sprouter up to 100 years of age (Buttrich 1921, Frothingham 1915, Morton 1920, Tillotson 1921, Zon 1929).

Diameter

Sprouting frequency and capacity of many hardwoods is high from stumps up to 15-20 cm in diameter (Buttrich 1921, Church 1960, Frothingham 1915, Johnson 1979, Little 1938, McGee 1978, Roth and Sleeth 1939, Sander et al. 1976, Spaeth 1928, Stroempl 1980), but tends to decline with increasing stump diameter. For example, sprouting frequency

of red oak declines to near zero on stumps of trees with diameters over 65 cm (Fig. 6, 7). Only one stump produced a clump of sprouts out of ten red oak stumps 40-60 cm in diameter 80-85 years old (Stroempl 1980). For a range of diameter classes, sprouting frequency of red oak was superior to white, black and scarlet oak, red maple and white ash, but less than chestnut oak (Table 2). Sprouting capacity may decline with increased stump diameter in sugar maple, or increase and then decrease in red maple (Fig. 8).

TABLE 2. Average percentage of oaks, white ash and red maple stumps expected to sprout after cutting (sprouting frequency)[1] (Sander et al. 1976, Spaeth 1928).

DBH class parent tree	White oak	Black oak	Red oak	Scarlet oak	Chestnut oak	White ash	Red maple
cm			percent				
5 - 13	90	90	100	100	100	100	100
15 - 28	70	75	80	80	100	90	65
30 - 41	20	50	65	60	80	40	10
43+	5	0	40	10	50	0	0

[1] Data rounded up to the nearest multiple of five.

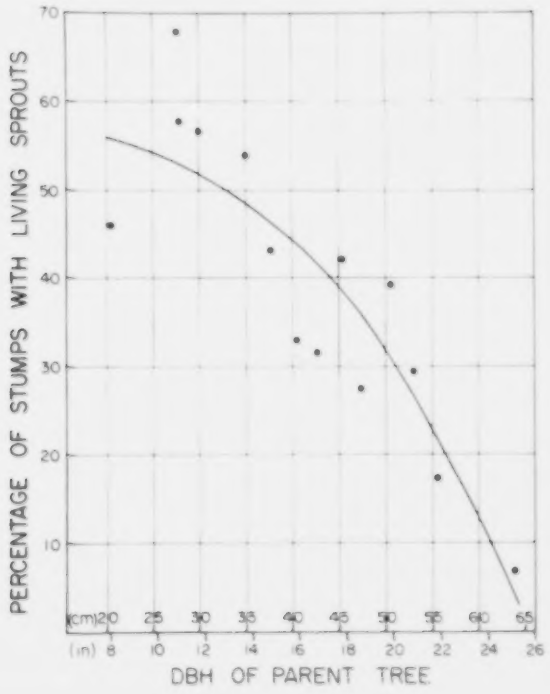

FIGURE 6. Percent of red oak stumps sprouting in relation to indirectly measured parent tree dbh (Johnson 1975).

FIGURE 7. Red oak stump 16 cm diameter 28 years old (left) produced sprouts more vigorous in height and diameter (frequency 94%) than stump 30 cm diameter 75 years old (frequency 38%) (right), in the first growing season after cutting.

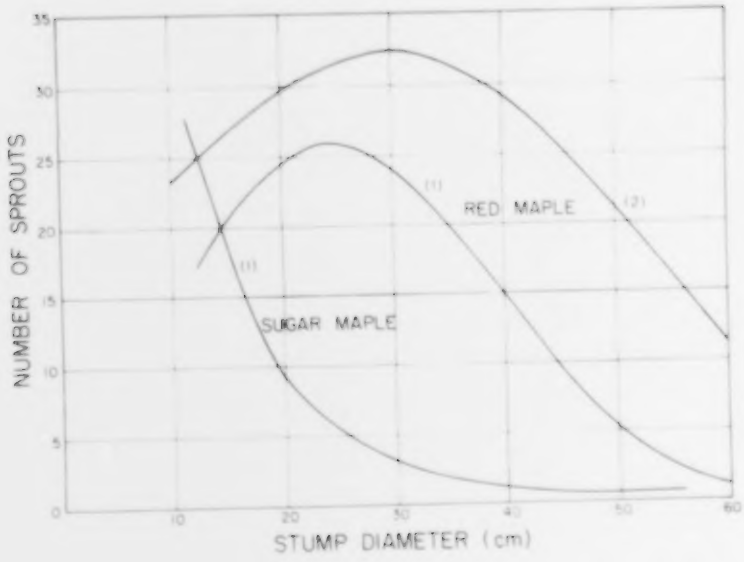

FIGURE 8. Relationship of the number of sprouts per stump (sprouting capacity) to average stump diameter for sugar maple and red maple, curve 1, (Solomon, Blum 1967) and for red maple, curve 2, (Prager, Goldsmith 1977).

c/ Location of Sprouts on the Parent Stump as Related to Decay Incidence

The most common entrance point of decay is from the death of small suppressed sprouts at the base of the larger ones (Shigo 1980). A stub next to a companion sprout in V-type connections likewise provides an entrance for decay. In clumps originating on high-cut stumps in oak stands 40-50 years old, most sprouts were attached high on the stump and were presumed decay prone (Johnson 1980).

Decay will seldom form in a U-type union of two sprouts if both originated at or below ground line. However, similar unions may result in decay if they originated higher on the stump (Roth and Hepting 1943a, Roth and Hepting 1969). The probability of a red oak sprout originating on the stump 2.5 cm above the ground line becoming decayed was at least twice as great as one originating at or below the ground line. Sprouts, albeit healthy, originating near the top of a high stump are also highly susceptible to breakage by wind and other factors (Roth and Sleeth 1939, Vogenberger 1931, Wilson 1968).

Decay that might develop in the remaining sprout will remain confined to an area approximately as large as the diameter of the sprout at the time of the cut (Shigo 1980). In timber stand improvement work in sugar maple and red maple of sprout origin, the fungus Daedalea unicolor (Bull.) Fr. is particularly important because it fruits on dead or cut companion sprouts. Even a low connection between several sprouts in a clump does not prevent decay (Campbell 1939). Therefore, sprouts in clumps infected with D. unicolor should not be considered as potential crop trees.

III. THEORY AND METHODS OF THINNING CLUMPS OF SPROUTS

There is a negative relationship between the number of sprouts per clump and their individual growth rates. Residual stems within sprout clumps responded to thinning by an increased growth in height (McIntyre 1936, Troup 1952), diameter (Gruschow 1955, Johnson and Rogers 1980, Roth 1956, Stockeler and Arbogast 1948, Trimble 1974, Troup 1952) and volume (Troup 1952).

Theory

Initially, high clump density and thus leaf areas (to support the parent-tree's root system) is associated with rapid height growth of shoots (Johnson 1975). The degree of stand openings will obviously also have an effect on the growth of stem sprouts regardless of the clump density. Generally, the effect of clump density on rapid height growth of shoots may persist for a maximum of about 15 years, but in red oak it was limited to the first 3-4 years at most (Johnson 1980).

After about age 15 years, only five or fewer sprouts usually remain, regardless of stump age, as a consequence of competition and natural thinning (Johnson 1977, McIntyre 1936, Rogers and Rogers 1959, Schwarz 1907, Vogenberger 1931). Up to 90% of the sprouts may die or break off in the first 10 years, but the remainder compete for dominance which frequently changes; thinning should therefore be delayed until dominance is clearly established (Wendel 1965).

In 25-year-old white oak clumps, the diameter growth of individual stems of the same diameters, or in clumps of various diameters, was greater 11 years after thinning than in unthinned clumps of any diameters (Haney 1962). However, in the same stand, the total basal area growth and merchantable volume growth in clumps with stems of the same diameters as well as various diameters was greater on the average in the unthinned clumps than in the thinned clumps with one stem remaining.

The probable performance of individual stems in young red oak clumps was estimated by a growth model (Johnson and Rogers 1980), based on 25th-year performance of thinned and unthinned sprout clumps for a wide range of different initial stem dbh, age, relative basal area and site quality. The effect of thinning at a given age can be compared to expected growth of the same stem in average unthinned clumps. For example, on good sites in Missouri Ozarks, a clump thinned to one 2.5-cm stem at age 5 can be expected to produce a tree 27.4 cm dbh at age 25; in contrast, the same stem in an unthinned clump (3 or more stems) would be expected to be 16.5 cm dbh, or 40% smaller. The same stem in a clump thinned to two 2.5-cm stems would be expected to reach 22.3 cm dbh at age 25. Such estimates can provide an objective basis for selecting crop stems when thinning young clumps.

For white oak stumps, the probability of producing at least one live sprout at the end of the first growing season after cutting has been related to stump characteristics (Fig. 9), whilst the chances of such a sprout becoming at least codominant in the new stand after five years is shown in Fig. 10 (Johnson 1977).

In white oak on good sites, the diameter and volume growth of the single largest stem in thinned sprout clumps was significantly greater than that of the largest stem in unthinned clumps (Haney 1962). However,

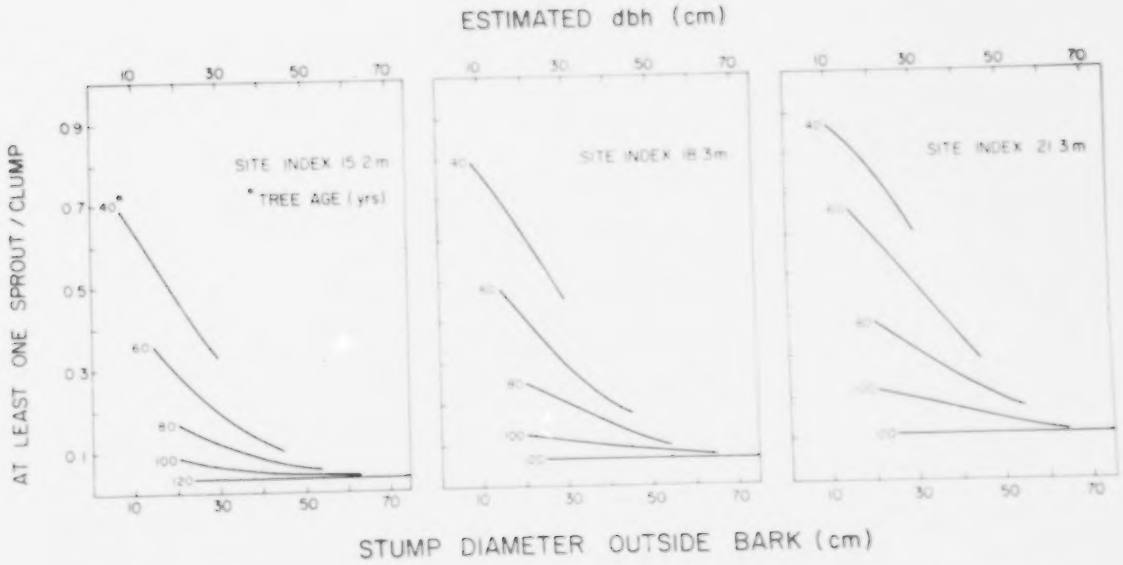

FIGURE 9. Estimated probabilities for white oak that a stump will have at least one living sprout at the end of the first growing season after cutting, in relation to stump diameter, tree age, and site index (Johnson 1977).

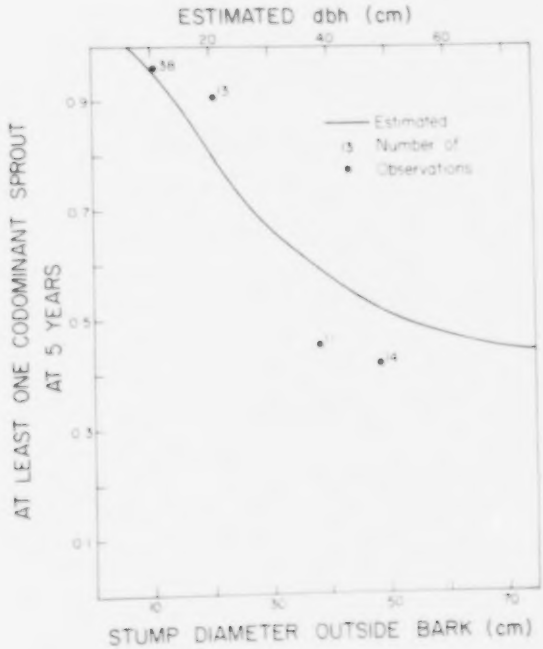
ESTIMATED dbh (cm)
AT LEAST ONE CODOMINANT SPROUT AT 5 YEARS
Estimated
Number of Observations
STUMP DIAMETER OUTSIDE BARK (cm)

FIGURE 10. Estimated probability for white oak that a stump with a living sprout at the end of the first growing season after cutting will have at least one codominant-or-larger[1] sprout five growing seasons after cutting, in relation to stump diameter (Johnson 1977).

[1] Trees 2.9 m in height or taller.

on poor sites more diameter and volume growth was produced by all stems in the unthinned clump. This was true for both groups of stems of the same diameters as well as of various diameters. On the good sites, the growth response was great enough to warrant thinning, either to carry the young stand through to small sawlog size, or to reduce the waiting period for a merchantable crop.

Methods

It is most practical to thin to 2-3 sprouts per clump before age 20 and, depending on the position of sprouts to each other, later reduce the clump to one sprout (Dana 1930, Eyre and Zillgitt 1953, Gruschow 1955, Joranson and Kuenzel 1940, Morton 1920, Ostrom and Hough 1944, Richardson 1927, Schwarz 1907, Shigo and Larson 1969, Stockeler and Arbogast 1948, Tubbs 1977b, Wendel 1975). Generally, sprouts up to a dbh-limit of 7.5-10 cm permit an easy selection of potential crop trees and a reasonably safe thinning of clumps without creating a decay hazard (Campbell 1938, Hepting and Fowler 1962, Jemison and Hepting 1949, Roth and Hepting 1943b).

When marking clumps, prime consideration should be given to the relative position of quality-sprouts which will determine the selection of the desirable sprouts and timing of the cut (Figs. 11, 12, 13). Clumps with multiple sprouts close together that are competing for early dominance, should be treated before difficulties associated with stem fusion and distribution occur (Fig. 14). Where isolated clumps exposed to full sunlight occur, companion sprouts in U-type connections can be temporarily retained to protect the boles against sunscald and development of epicormic branches (Figs. 15, 16). Older clumps with fused stems resulting in forks should not be thinned (Fig. 17), unless one companion stem is of considerable smaller size (Fig. 18). The reason for cutting a clump should always be clear to prevent needless disturbance of the valuable ground cover (Fig. 19).

Cutting stumps as close to the ground as possible, or recutting high stumps, is therefore advantageous, particularly for trees that are pole-size or smaller. A red oak stump 15 cm in diameter recut at ground line typifies the numerous vigorous sprouts that developed in the first growing season (Fig. 20). Sprouts from below the ground line often display early dominance over those high on the stump (Fig. 21). Numerous sprouts originating from below the ground line and at a distance from the stump are best prospects to develop healthy, vigorous crop trees (Fig. 22).

In red maple, branch stubs were more serious infection courts for organisms causing decay and discolouration than were parent stumps (Shigo 1965). Red maple sprouts with an abundance of large branches and branch stubs are of less value even if their base is sound. However, if the stems are clear of branches and the branch stubs are small and well healed, they are potentially of high value, even if their base may be defective (Fig. 23). In oak sprouts, however, it is strictly the condition of the base which predisposes the decision in retaining or rejecting sprouts as future bearers of value (Roth and Sleeth 1939, Roth and Hepting 1943a, Roth and Hepting 1943b).

FIGURE 11. Clump of three widely-spaced white birch sprouts 7.5-10 cm dbh (in foreground) offers several options for selection of equal potential, depending on the crowns' qualities and available growing space. Clump of three white ash sprouts 7.5-14 cm dbh (in background) should have been treated before union of stems occurred.

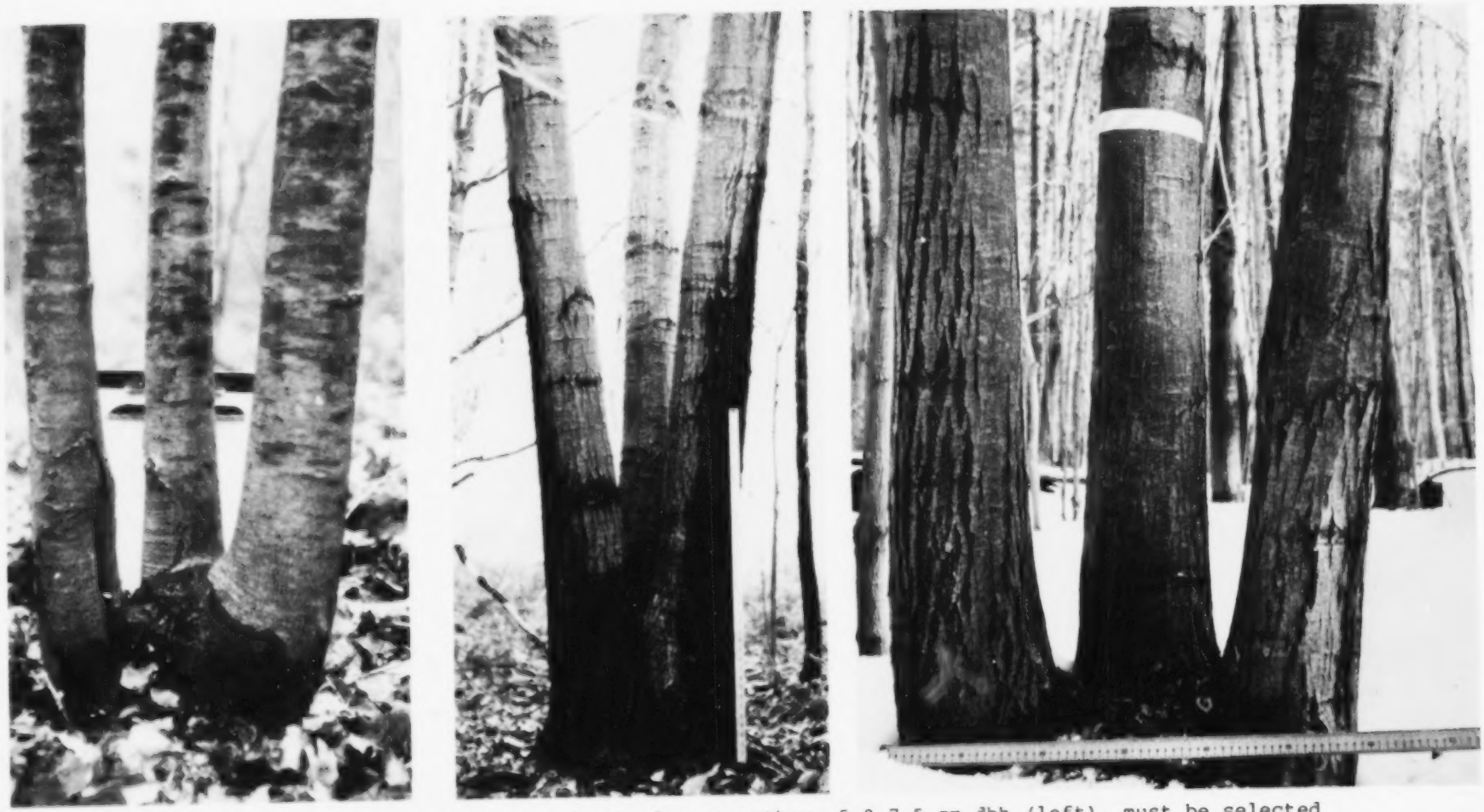

FIGURE 12. One sprout in a clump of three red oak close together, 5.0-7.5 cm dbh (left), must be selected very early in life to prevent a difficult cutting situation when they reach 18-23 cm dbh (centre). Selection in a clump of three high-quality sprouts can be conveniently delayed if they are at some distance from each other (right).

FIGURE 13. U-type connections between two stems should be encouraged in thinning clumps. Red oak stems 2 and 3 should have been cut and stem 4 left.

FIGURE 14. Clump of 18 red maple sprouts 1-10 cm dbh. A large number of multiple stems close together should be thinned as soon as dominance of 2-3 stems becomes apparent to prevent difficulties in selecting and cutting. Stems 1 and 2 should have been selected several years ago along with two stems farthest away to shade their boles, and the rest cut.

FIGURE 15. Red oak clump of 10 sprouts 2.5-11.5 cm dbh. Two stems out of 4 marked should be selected as those of potential log quality. Two of the smaller-size stems can be kept to shade their boles and the rest cut.

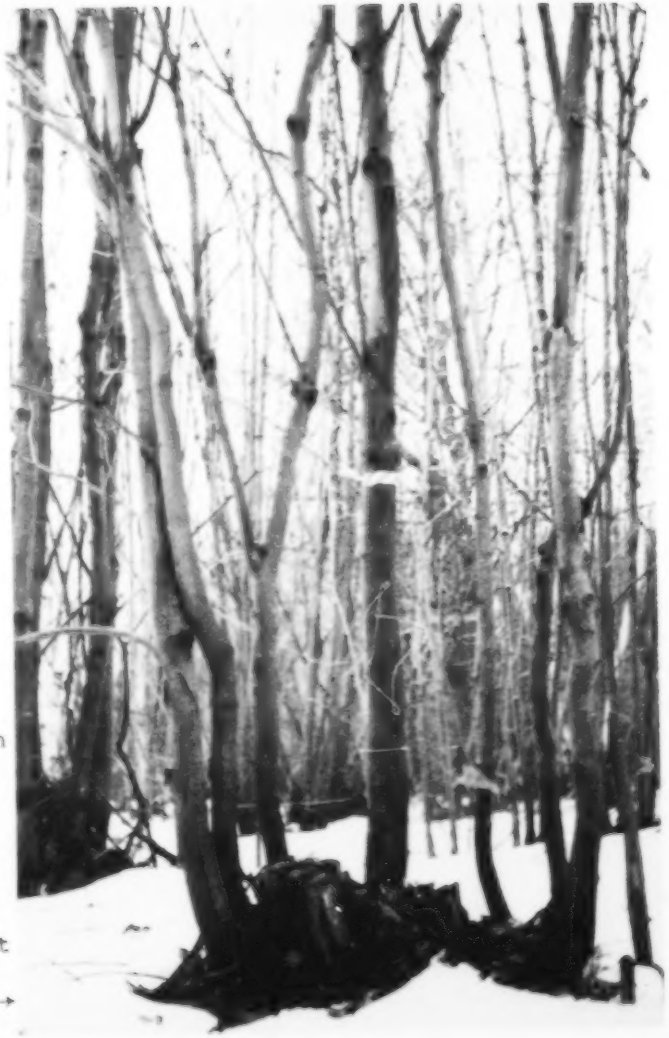

FIGURE 16. Clump of 7 red maple sprouts 3.8-6 cm dbh containing one well-isolated, high-quality dominant stem (with ribbon); stems surrounding the dominant can be left to shade its bole.

FIGURE 17. High stumps left as part of forks are always unacceptable. Note exposed wood and long seam making this red oak stem of questionable value. Both stems should have been cut.
←

FIGURE 18. If one companion stem of a forked (red oak) is of considerable smaller size, it should be pruned early as a branch close to the bole to encourage healing over of the wound (see line).
→

FIGURE 19. Clumps of sprouts should be either thinned to promote growth of selected stems or left alone as valuable ground cover and "trainers" of other stand components. This clump was cut needlessly. Note high cut of stumps and poor sprout development.

FIGURE 20. Red oak stump 15 cm diameter recut at 1.5 cm produced 34 sprouts mostly from below the ground line in the first season.

FIGURE 21. Red oak stump 4 cm diameter produced two high-quality dominant sprouts originating below the ground line and one suppressed sprout high up on the stump. Dominant sprouts reached 2.4 m after three growing seasons. Note difference also in diameter.

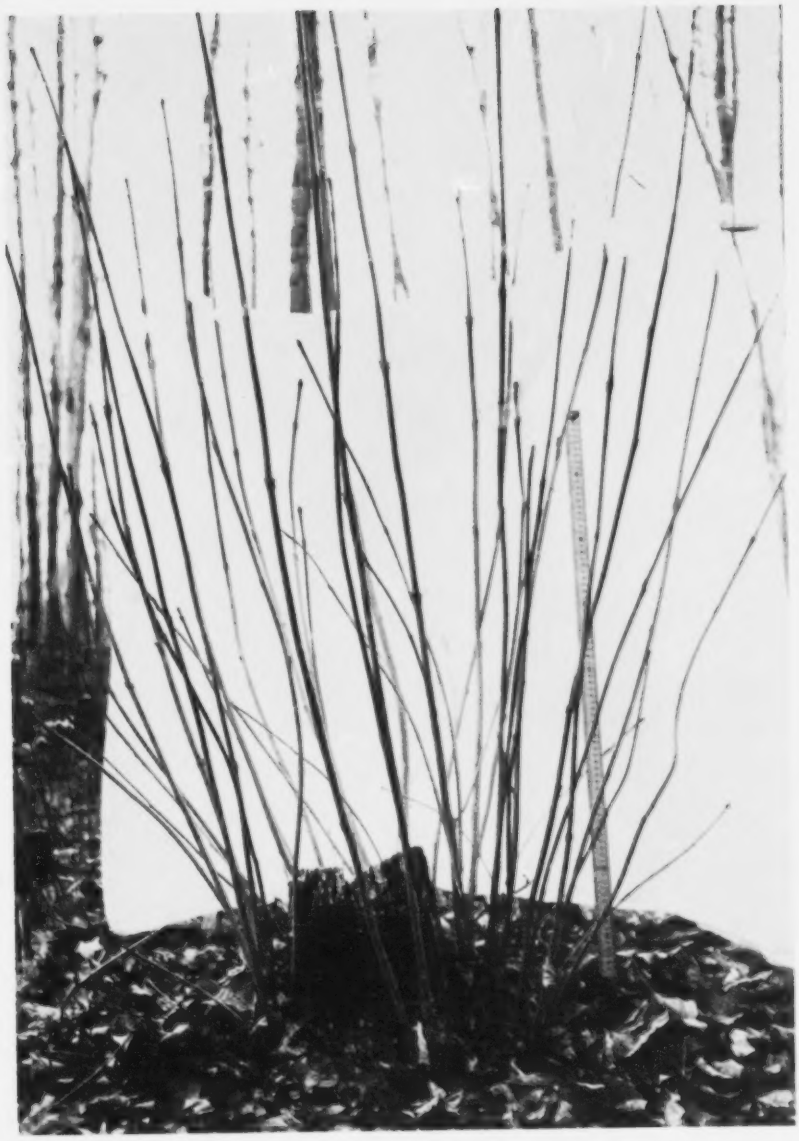

FIGURE 22. White ash stump 18 cm diameter with one-year-old sprouts up to 2.5 m high. Vigorous multiple sprouts from below the ground line are highly desirable encouraging severe competition and early dominance.

FIGURE 23. Clump of 5 red maple sprouts 6.5-8 cm dbh (left) contains numerous low branches and scars lowering their potential to develop log quality. Clump of 14 sprouts 3-6 cm dbh (right) contains no branches and few scars increasing their potential to develop log quality.

IV. RECOMMENDATIONS TO ENCOURAGE SPROUTING AND TO THIN CLUMPS

How standing trees are cut can determine the success or failure to produce high-quality stems from subsequent clumps of sprouts. Two objectives can be considered: 1/ encourage rapid regrowth from stumps of cut trees, and 2/ encourage maximum growth of selected stems by thinning of the resulting sprout clumps. To achieve these objectives the following actions are recommended:

* To encourage sprouting, parent trees should be cut during the dormant season, i.e., from late fall to early spring, before bud break. This will insure sufficient time for sprouts to become hardy before fall frosts occur and a larger proportion of fast-growing sprouts will result than when a tree is cut just after full leaf expansion in the spring.

* Stumps should be cut with a saw as low as possible and bark damage should be avoided. The most healthy sprouts will originate at or below the ground line, because sprouts originating high on the stump are eventually susceptible to decay, wind throw and snow breakage.

* Recut high stumps closer to the ground to encourage more sprouts to develop from below the ground and to accelerate the healing-over of small stumps and decomposition of large stumps.

* Cut damaged or otherwise unsuitable advanced-growth during cleanings to produce desirable seedling-sprouts.

* Thin clumps at an early age, preferably before the sprouts reach 20 years. If not thinned early, sprouts may become decayed through the advancing rot from dying companion sprouts. Moreover, severe competition among sprouts causes them to lean and become crooked.

* Favour best-formed, most widely-spaced, low-origin dominant or codominant sprouts with U-type connections between companion sprouts. V-type sprout connections should be treated as a unit -- either left or both cut.

* When selecting the best-formed stems in a clump, particular attention should be paid to the branch stubs: their number, size and degree of healing affect greatly the future quality of the tree.

* Companion sprouts in U-type connections can be temporarily retained to protect the bole of the selected dominant against sunscald and development of epicormic branches.

* Provide maximum space for crown development which is important for fast growth of young sprouts.

APPENDIX

Common name	Scientific name
Basswood	Tilia americana L.
Black cherry	Prunus serotina Ehrh.
Black oak	Quercus velutina Lam.
Black walnut	Juglans nigra L.
Bur oak	Quercus macrocarpa Michx.
Butternut	Juglans cinerea L.
Chestnut oak	Quercus prinus L.
Hickories	Carya Nutt.
Ironwood	Ostrya virginiana (Mill.) K. Koch
Red maple	Acer rubrum L.
Red oak	Quercus rubra L.
Scarlet oak	Quercus coccinea Muench.
Silver maple	Acer saccharinum L.
Sugar maple	Acer saccharum Marsh.
White ash	Fraxinus americana L.
White birch	Betula papyrifera Marsh.
White elm	Ulmus americana L.
White oak	Quercus alba L.
Yellow birch	Betula alleghaniensis Marsh.

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